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Collagen Crosslinks*

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The present study was designed to elucidate mechanisms of laser welding by investigating the effects of defined laser exposure on collagen crosslinks. Since crosslinks serve as major determinants of the physicochemical properties of collagen, they may have a direct influence on immediate post-weld strength as well as long-term stability of laser-welded tissue. Calf tail tendon was exposed to a diode laser (805 nm) after application of indocyanine green dye (ICG), with output power set at 1,2,4, or 8 watts of power; average duration of exposure was 30 seconds. A control was treated with ICG, but not exposed to laser light. Samples were analyzed for the reducible crosslinks dihydroxylysinonorleucine (DHLNL), hydroxylysinonorleucine (HLNL), and the nonreducible trifunctional crosslink hydroxypyridinium (OHP). Multiple sections of each tendon were analyzed to assess homogeneity of tissue response to laser irradiation.

Laser exposure significantly affected crosslink content; specific effects were a function of power output and the crosslink type. From these studies we conclude that: (1) it is feasible to expose collagen, at least under certain conditions, to laser energy at high power outputs without affecting normal crosslinking and, by inference, spatial organization of collagen molecules; (2) optimal laser protocols for tissues with high content of DHLNL and OHP may differ from that appropriate for tissues in which HLNL predominates; (3) monitoring crosslink loss may serve as a useful guide in optimizing laser welding protocols; in addition, crosslink content may also be valuable as a feedback parameter during the welding process itself, particularly if nondestructive optical methods can be developed for this purpose.

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